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ABSTRACT

This study investigated the attitudes and opinions of 970 students with and without learning disabilities regarding the use of computers for school-related work. Using a quasi-experimental design with three non-equivalent groups, within and between subjects effects were studied using a survey instrument. The students in grades 5 through 12 at three school sites completed pre- and post-test surveys at the beginning and end of the school year. One site served as the experimental group, while the other two were control groups. The experimental condition consisted of the installation of a campus-wide computer network for use by all students at the experimental site. A 24-item scale measured participants' attitudes about the general use of computers in schools and the use of computers by students with special needs. The most significant variables related to students' attitudes and opinions were their past experiences using computers and their school affiliation. These data also showed there was no relationship between the installation of a campus-wide computer network and changes in students' attitudes and opinions about computer use in special education. There were no significant differences in attitudes toward computers between students with and without learning disabilities. (Contains 25 references.) (Author/CR)

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Running Head: COMPUTERS

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Computer Attitudes and Opinions Of Students With and Without Learning Disabilities

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Abstract

There is little research regarding the use of computers among students with learning difficulties. This study investigated the attitudes and opinions of students with and without learning disabilities regarding the use of computers for school-related work. Using a quasi-experimental design with three non-equivalent groups, within and between subjects effects were studied using a survey instrument. The students, in grades 5 through 12, at three school sites, completed in pre and post-test surveys at the beginning and end of the school year. One site served as the "experimental" group, while the other two were control groups. The experimental condition consisted of the installation of a campus-wide computer network for use by all students at the experimental site. A 24-item scale measured participants' attitudes about the general use of computers in schools and the use of computers by students with special needs. The most significant variables related to students' attitudes and opinions were their past experience using computers and their school affiliation. These data also showed there was no relationship between the installation of a campus-wide computer network and changes in students' attitudes and opinions about computer use in special education. There were no significant differences in attitudes towards computers between students with and without learning disabilities.

Computer Attitudes and Opinions Of Students With and Without Learning Disabilities

Computers have had a major impact on modern society. In the last two decades they have changed the conduct of business and industry around the world. Computers have also influenced education, but not as dramatically as the changes in the workplace. Many educators and lay persons see computers as a positive addition to classrooms while others view them as unwelcome foreign invaders. The use of computers for instructional purposes grew considerably in the last decade and it appears that their use will continue to expand (Blackhurst, 1997; Bork, 1997; Molnar, 1997).

From the first days of instructional technology, educators who work with students with special needs have recognized the opportunities that computers can offer such students. Early services included adaptive and assistive devices for students with communication disorders and mobility impairments. More recently, instructional technology has been used with students with so-called mild disabilities, (e.g. learning disabilities), as a tool for practicing skills, remedial work, and strategy instruction. Given the increasing costs of special education services, it is important to determine whether such technologies offer supports and services for students with special needs that are not otherwise available. An increasing body of research indicates that computers and other forms of instructional technology are positively related to student achievement, as measured by both curriculum-based and standardized outcome variables (Fletcher-Flinn & Gravatt, 1995; Khalili & Shashaani, 1994; Kulik, 1994). Other studies have shown that instructional technology can be especially effective for students with special needs (Fitzgerald & Koury, 1996; Goldenberg, 1984; Male, 1994).

One important variable that has not been extensively studied is the attitudes and opinions of students about the use of technology in schools, both in general and as this technology relates to students with special needs. The lack of data about student attitudes is significant because the attitudes students

hold are likely to influence their actual use of computers. Students' beliefs about computers are likely to shape the extent to which instructional technology enhances their achievement -- academically, socially, or personally. This study investigated students' attitudes and opinions concerning the use of computers in schools with a special focus on the use of instructional technology by students who perhaps stand to benefit the most from it: students with special learning needs. The purpose of this research was to learn whether students with and without learning disabilities believe that instructional technology makes a difference in students' learning, whether these students believe that instructional technology can benefit students with special needs more than others, whether their own computer skills are related to these beliefs, and whether there are differences in the computer attitudes and beliefs of students with and without learning disabilities. These data provided indicators of the relationships between students' computer skills and experiences and their attitudes about the role of computers in school-based instruction.

Previous investigations of both teachers' and students' computer-related beliefs were considered in designing this study. A few studies looked at both students' (King, 1995; Kinnear, 1995; Proctor & Burnett, 1996; Riggs & Enochs, 1993) and teachers' (Delcourt & Kinzie, 1993; Marsh, 1995; Moore, Rieth & Ebeling, 1994; Murphy, Coover & Owen, 1989; Olivier & Shapiro, 1993; Siegel, Good & Moore 1996; Yaghi, 1996) beliefs about computer use in schools and offered preliminary findings about attitudes, opinions and overall use. The Riggs and Enochs (1993) as well as the Murphy et al. (1989) studies suggested methods for how to construct a computer beliefs instruments. King's (1995) study showed that students do not always perceive computers as generally helpful, and that other variables influence their usefulness. Proctor and Burnett (1996) found that frequency of access and use of computers is related to student attitudes. Kinnear's (1995) work suggested that more study of how students perceive computer use is needed.

Delcourt and Kinzie (1993), Moore, et al. (1994) and Siegel, et al. (1996) pointed to the need for far greater teacher training in the use of computers. Yaghi (1996) found that there is a need for greater integration of computers in the overall curriculum. Marsh identified the importance of "making special education portable" by using computers as part of inclusive practices in special education (Reynolds & Birch, 1988, cited in Marsh, 1995). Olivier and Shapiro (1993) showed that there is a very high correlation between use and computer efficacy among students. This finding, more than the others, points to the importance of understanding more about students' computer skills, beliefs and attitudes. While the prior research has shown that computers are related to positive outcomes in student achievement, little research has been done to learn about the relationships between computer use and students' attitudes and opinions about their use. Some researchers have found that computers can be especially useful for students with special needs (Church & Bender, 1989; Fitzgerald & Koury, 1996; Goldenberg, 1989; Goldenberg & Russell et al., 1984; Kearsley, Hunter & Furlong, 1992; Male, 1993, 1994) but little research has investigated whether students are aware of these findings or even hold such beliefs.

Research Questions

The specific research questions addressed in this study are:

1. Do attitudes and opinions about student computer use in schools differ among students from different schools and between students with and without learning disabilities?
2. What factors are related to the attitudes and opinions of students with and without learning disabilities regarding student computer use in schools?
3. Do perceptions about the use of computers in schools and the quality of student performance differ between students with and without learning disabilities both before and after installation of computers throughout the school?

These questions were designed to help reveal what students believe about the use of computers in schools and how they perceive computers to influence instruction and student performance. This information should provide a better understanding of the role computers play in schools, and whether computers are especially helpful for students with special needs. The unique opportunity to survey students and teachers at the inception of a new computer network provided a chance to investigate how such expanded computer services are related to students' attitudes about computers. The research literature suggests that installation of expanded computer resources would be beneficial to students and may be related to certain student outcome measures such as grades, standardized test scores, and overall attitudes about computers (Delcourt & Kinzie, 1994; Murphy, et al., 1989).

Method

A survey questionnaire was administered twice. First in October, just at the start of the implementation of the treatment school's new computer network, and again in May, after the new computers had been used by students for school work. The data were analyzed by comparing the survey scores from the beginning and the end of the year across the experimental and control schools. Relationships among demographic and survey variables were also investigated. Although the non-equivalency of the groups diminished the overall degree to which group differences can be attributed to the installation of instructional technology, they do reflect real-world differences present among these schools and allow for a comparison of pre and post-test results as well as treatment effects. Interpretation of the results included consideration of pre-existing differences among the non-equivalent groups.

Participants

The data were collected at three different schools: Riverview, a public elementary school with grades pre-k through 6, Fairmont, a private boys' boarding school for grades 6-9, and Wesley Academy,

a private co-educational boarding school for grades 7-12.[1] All three schools are located in non-urban communities in the Northeast United States. For the purposes of this study, students in grades 5 through 12 participated. The sites were chosen because they are located in communities near the university where the researchers are affiliated. Initially, Riverview and Fairmont were both selected for this study because they planned to implement new computer networks. Due to scheduling and funding problems, the computers for Riverview were not installed at all during the school year when the study was conducted. Given that some data were already collected, it was decided that the students at this site would still participate and serve as additional controls. Thus, the new computer network at Fairmont became the "experimental" condition and Riverview and Fairmont were "control" conditions at which no new computer equipment was installed. Demographic information for the students at all three schools is given in Table 1.

<Insert Table 1 about here>

Installation of New Computers

The computer (experimental) school, Fairmont, is a middle grades boarding school. The school admits boys, and a few girls, in grades 6 through 9. Demographic data about the school's students at the time of the study are found in Table 1. Approximately 25 percent of the students were day students from surrounding towns and the rest were boarding students. Of the day students, a small number (around 8%) were girls because the daughters of faculty and staff are permitted to attend the school. On average, the school has a very diverse population with students from up to 30 states and 11 foreign countries. Of the 250 students who participated in the study, approximately 21 percent were international and not native English speakers (n = 52). The school's students represent a very diverse range of academic abilities. Ten percent (n = 26) of study year students had diagnosed learning disabilities (LD), 8% had Attention Deficit Hyperactivity Disorder (ADHD; n = 19); four students had

[1] School names are pseudonyms

both a learning disability and ADHD. In addition, one student with a hearing impairment and one student with physical disabilities attended the school. Overall, the school's population of students with special learning needs was 16 percent, slightly above the national average of about 12 percent. Students with special learning needs are fully included in all regular classes, with the occasional exception of a foreign language waiver being granted to students with language learning disabilities. Most of the students with learning disabilities or ADHD attend the school's resource room program one period a day. Additional academic support is provided when needed by privately hired tutors. The school also has a number of students with very strong academic skills, including students who have participated in nationally screened programs for students identified as talented and gifted.

Instructional Technology Program

The "treatment" condition evaluated in this study was the implementation of a school-wide technology plan (Solberg, 1996). At the center of this plan was the installation of a school-wide wide area network (WAN). This WAN connected the classrooms, library, faculty work areas, administrative offices, and dormitories on one network. The backbone of the WAN is fiber optic cable that connects each building to the main servers. Category five (UTP) data cabling was used within buildings for individual workstation connections. The existing computer lab was completely re-done and 14 new, network capable, Power Macintosh computers for student and faculty use were installed. During the study year the computer room was available for individual and class use throughout the class day and for individual student and faculty use during the afternoon study hall hour. It was also made available to boarding students during free times on weekends for academic projects. These computers provided a range of software, including Microsoft Word, Claris Works, Hyper Studio, and several typing tutorials. Seven of the computer room computers were linked to the network, allowing Internet access for supervised use exclusively during elective periods

The existing search station computers in the library, five Hewlett-Packard Vectra 4/66 series, were updated with new software for electronic database searches. An additional IBM Pentium series Internet station was added for student and faculty use. Four of the old computer room Macintosh LC II computers were placed in the library equipped with Microsoft Word and Internet software for student use. All of the classrooms in the main classroom building were wired with category five data transmission cable for teachers to use to connect computers for classroom use. Two of the old computer room Macintosh LC II's were placed in the special education resource room; both included Microsoft Word and a typing program; one had Internet and e-mail access. The remaining Macintosh computers were equipped with network cards as well as Microsoft Word and e-mail software and placed in the commons rooms of each dormitory. These computers were made available for student e-mail and word processing use during the students' free time and study halls.

No school-wide training for students was provided because individual faculty incorporated computer use and instruction in some of their classes. The English department established a computer literacy program for all students in the ninth grade. This program consisted of direct instruction in basic word processing skills by the computer teacher and the requirement that certain English assignments be completed using a word processor. In addition, computer-related elective courses, ranging from typing, Hyper Studio, Internet use, and computer rendering were offered throughout the school year. These programs were supported by one full time computer teacher and a full time computer coordinator. In addition, several students organized and taught two computer related classes with the support and supervision of faculty members.

Comparison Schools

Both Riverview and Wesley Academy served as control sites for this research. Both these schools had some computer facilities on campus but no new academically-related equipment was installed during the school year when the study was conducted.

Riverview

A public elementary school serving students in grades pre-kindergarten through 6 served as one of the control sites. As stated, this school was to have served as a second experimental site, however, the planned computer network was delayed by one year. Opened the year the study was conducted, this school was designed with the use of technology in mind. The necessary wiring to support academic and administrative computing was installed at the time of construction. The funding to purchase the necessary computer hardware and software was provided by a supplementary budget. As a result these items were not in place when the school opened. The school provides a range of special education services on site, ranging from mild to severe special needs. Where possible, inclusive educational practices are used to provide students with special needs an education in the least restrictive environment (LRE). Fifteen percent (n = 55) of the school's students received special education services, 10% (n = 39) were eligible for free and reduced lunches, and 6% (n = 23) were non-native English speakers. Among the students who participated in the study (n = 108), 14 (13%) were identified as having special needs and were receiving special education services via an individualized education plan (IEP).

Existing computer resources from the two former elementary schools were brought over to the new school when it opened. These resources included several administrative computers and 14 stand-alone Commodore 64 computers which were placed in the fifth grade math teacher's classroom. In addition, all the other fifth and sixth grade teachers had one Apple IIe computer in their classrooms for student and teacher use. There was no appointed technology teacher, but one of the fifth grade teachers served as the unofficial coordinator for the building during the study year.

Wesley Academy

The secondary school site was chosen for two reasons. First, this school has a well-established program for students with special needs and such students represent about 15% of the student body (n =

49 students). Second, no additional computer resources were planned for the year the study was conducted. Wesley is a co-educational private boarding school with traditions dating from before the U.S. Civil War. The school enrolls students in grades 7 through post-graduate year. Students in the middle school, grades 7 and 8, have their own program and separate classes and most middle school students are day students. The school attracts a diverse student body with an international student population of approximately 18 % (n = approximately 60). Specific information about subtypes of special needs was unavailable, however, the support program is designed for students with specific learning disabilities. Students with disabilities are fully included in all regular classes, with the exception of some language waivers. Specific learning needs are addressed during daily one-on-one sessions with the special education faculty members.

Existing technology resources included a computer lab with 12 Macintosh and 4 Power Macintosh computers. This lab was available for individual and class use throughout the class day and during study hall times during the study year. In addition, each department chair had a Power Macintosh or Macintosh computer in the departmental office. All the middle school classrooms had one Macintosh Classic or SE computer for student use. Most administrative offices had stand-alone computers. The library had two single-user CD-ROM search stations and software for student and faculty use. The card catalog was not computerized. There was no central computer network or server. Modems were available for use by students with their own computers in the dorm and for department chairs to use for Internet connections. There was one part- time technology coordinator.

Selection of Students and Participant Consent

Subject selection was not random, but involved all the students and teachers at the three sites who were willing to participate, with the exception of an age-selected group at the elementary school. While enrollment at the two private schools is by admission only, these schools have traditionally admitted students with varying ranges of ability, including students with special needs. Thus, the

population of students with special needs at these schools (15-16%) is near enough to the national average of 12% to make the results potentially generalizable to the overall population of students with special needs. The parents of the students were contacted by mail to inform them of the survey at least two weeks before any data were collected. Passive consent for the survey was assumed unless the parent(s) contacted the researchers. The students were informed of their right not to participate in the survey in the cover letter accompanying the survey.

Survey Instrument

The attitude data were collected using the Computer Opinion Survey (COS). This questionnaire consisted of 24 Likert-type questions from which two subscores were derived. Questions for the survey were written by the first author based on other similar instruments found in the literature (Delcourt & Kinzie, 1993; Kinnear, 1995; Murphy, et al., 1989; Olivier & Shapiro, 1993; Riggs & Enochs, 1993). Items and item descriptions from the above studies were used in the creation of the items for this survey. The items created for the instrument used in this study concentrated on two categories not covered by previous research: 1) general attitudes and opinions held about the use of computers by students in schools, and 2) the use of computers by students with special learning needs. A separate subscore was computed for each category. The survey questions were initially reviewed by a panel of four experts familiar with survey development. Several questions were amended or omitted as a result of consultation with these colleagues. The survey was then pilot-tested and further revisions were made. After the survey was administered, an item analysis was conducted. The internal consistency reliability (coefficient alpha) of the survey scores for the 19 item general attitudes scale was .84. The four item set about the use of computers by students with special needs scale had an internal consistency reliability of .66. The survey items are presented in Table 2.

<Insert Table 2 about here>

In addition to the general and special needs attitudes items, an item related to whether new computers installed during the study year influenced student work was asked on the post-test version of the survey. All items allowed for one of five Likert-type responses, ranging from 1, strongly disagree, to 5, strongly agree. The survey was organized into three sections and all responses were written on a separate machine readable answer sheet. Section I included instructions for completing the survey and basic demographic information about respondents, including name, sex, race, grade, age, school, native language, citizenship, computer ownership/access, computer skills (self-reported), frequency of computer use, years of computer experience, types of computer use, grade/education, and special need/disability. Section II included additional demographic questions and questions related to subjects' access to and experience with computers. Section III comprised the survey items. The additional question relating to whether the new computers enhanced student work was asked on the post-test survey at all three sites.

For students at the computer school, Fairmont, the students' socio-economic data based on financial aid status were also collected. Such information was not available for students at the other schools. Day-student/boarding status was collected for students at Fairmont and Wesley Academy. The surveys were handed out and collected during the students' math and English classes. Students took approximately twenty minutes to complete the survey. Incomplete cases and those which appeared to reflect non-serious responses (e.g., all one Likert scale response) were deleted.

Data Analyses

The data were analyzed using SPSS, version 8.0. Statistical procedures were applied to answer each of the three research questions. Two primary outcome measures were used: (a) the sum of the items on the general attitudes scale (19 items), and (b) the sum of the items on the special learning needs scale (4 items). The post-test item about the relationship of computers to quality of student work served as an additional outcome measure. Except where indicated, all tests for significance were at the .05

level. Analysis of variance (ANOVA) and multiple comparison procedures were used to compare the means by school and group (student with or without learning disability) on each outcome measure. Multiple regression was also used to discern variables predictive of students' attitudes. For all subjects, the predictor variables were: race, sex, age, native language, computer ownership/access, computer skills (self-reported), frequency of computer use, years of computer experience, types of computer use, grade, and special need/disability. Regression procedures were also used to determine if differences in attitudes existed across the two student groups, after controlling for the other variables listed above.

Results

Data on both the pre-test and post-test surveys were not available for all students. Some students had missing data on the pre-test, while others had missing data on the post-test. Therefore, two strategies were used to analyze the data across groups. First, we analyzed the pre-test and post-test data separately. These analyses compared the responses of the students with and without learning disabilities from the different schools at the same point in time. Second, we analyzed the data for students who participated in both the pre-test and post-test surveys. The first set of analyses utilized all of the data available, while the second set of analyses allowed for investigation of change over time for the same students. The results of these analyses are reported below, as are the results of the multiple regression analyses.

Separate Pre-test and Posttest Analyses

Comparisons by School

The mean attitude scores for each school on the pre-test and post-test surveys are reported in Table 3. The means for each school were similar for the pre-test and post-test groups; however, the mean attitudes varied according to the school. A one-way ANOVA on the pre-test data revealed statistically significant differences across schools on the general attitude ($F_{(2, 619)} = 15.75$, $p = .0004$) and special needs ($F_{(2,649)} = 3.70$, $p = .025$) measures. On the post-test, only the differences across schools on the general scale were statistically significant ($F_{(2, 515)} = 14.62$, $p = .0001$).

<Insert Table 3 about here>

To determine which schools were statistically significantly different from each other, post-hoc multiple comparison procedures were used. Due to the unequal sample sizes coupled with the presence of heterogeneity of variance, the Games-Howell test was used. These tests showed that Riverview, one of the two control schools, had a mean general attitude score that was statistically higher than the other schools at the pre-test. On the special needs scale, significant differences were found between Fairmont (the "experimental" school) and Riverview only. As with the general attitudes scale, Riverview had a statistically significant higher mean (13.5) than Fairmont (12.6). At post-test, again, the general attitudes for Riverview students were significantly higher than the other two schools, but their mean actually decreased (the decrease was not statistically significant, $p = .524$). These findings do not support the hypothesis that putting computers in a school will improve students' attitudes toward them.

Comparisons between Students with and without Learning Disabilities

Similar comparisons were made between the groups of participants: students with learning disabilities and students without learning disabilities. Means and standard deviations for these groups for the pre and post-test are found in Table 4. Analysis of variance (ANOVA) results showed no significant differences between these groups ($F_{(2, 619)} = 2.75$, $p = .060$) for either outcome measure.

<Insert Table 4 about here>

Combined Pre-test/Posttest Analyses

The data for students who took both the pre-test and post-test surveys were analyzed using repeated measures analysis of variance (RMANOVA). There were 390 students who completed both the pre and post-test surveys, which represented 58% of the total number of students who took at least one survey. The means and standard deviations for these students are presented in Table 5. A three-way repeated measures model (school-by-group-by-pre to post-test change) was applied to investigate differences among school and student groups. Unfortunately, the homogeneity of variance test was not satisfied for this analysis ($F_{(15, 8369)} = .2.581$, $p = .001$), and coupled with the unequal samples sizes across

schools, these results were not interpretable. Therefore, separate two-way RMANOVAs were conducted: one, comparing the pre-test and post-test scores across schools (i.e., collapsing across students with and without learning disabilities), and the other comparing students with and without learning disabilities from pre-test to post-test (i.e., collapsing across schools).

<Insert Table 5 about here>

Comparisons Across Schools

Results of the RMANOVAs (collapsing across students with and without learning disabilities) revealed significant between-school differences on the general attitudes scale ($F_{(2, 387)} = 13.90$, $p = .0005$), but no significant changes in the students' attitudes over time. These data are summarized in Table 6 and Figure 1. The interaction (school-by-time) was also statistically significant ($F_{(2, 387)} = 4.22$, $p = .015$). The significant interaction and main effect for school is due to the decrease in general attitude from pre-test to posttest for the Riverview school only. For the special needs scale, the main effect for school was not statistically significant, but statistically significant effects were observed for time ($F_{(1, 395)} = 11.24$, $p = .001$) and for the interaction ($F_{(2, 395)} = 13.90$, $p = .007$). Once again, the main effect and interaction were due to Riverview, where there was a relatively large decrease (13.5 to 12.2) in the special needs attitude scores of the students from pre-test to post-test (see Figure 2). Given that: (a) the only statistically significant findings were related to the control school that exhibited the highest attitudes at pre-test, (b) the pre-test/post-test differences were relatively small, and (c) the differences for the control school reflected a decrease in attitude from pre-test to post-test, it is clear that changes in these attitudes over time are not related to the experimental condition of the computer network.

<Insert Table 6 about here>

<Insert Figure 1 about here>

<Insert Figure 2 about here>

Students with and without Learning Disabilities

Results of the RMANOVAs collapsing across schools are presented in Table 7. There were no statistically significant effects for the special needs scale. For the general attitudes scale, the main effect for time, and the interaction (time-by-group) were statistically significant. For students with learning disabilities, the score on the general attitudes scale increased almost three points from pre to post-test (from 67.0 to 69.8). For the students without learning disabilities, the score increase was less than half a point (67.3 – 67.7). Thus, the interaction is due to the relatively larger pre-test/post-test increase for the students with learning disabilities. Although this finding is interesting, the effect size was small (.03). Furthermore, the positive change in attitude from pretest to posttest was not associated with the "experimental" school (Fairmont), where very little change in attitude was observed across pre-test and post-test. Thus, the experimental condition of the new computer network did not appear to be related to changes in these students' attitudes about computers.

<Insert Table 7 about here>

Overall Sense of Change

In addition to comparing students' pre- and post-test responses, an additional item was included on the post-test to ascertain students' sense of how computers influenced school work during the school year ("I believe that the new computers installed this year have helped students to improve the quality of their work"). This item was targeted primarily at the experimental group, but was asked of all subjects, to investigate differences among the groups. The mean responses to this item for each student group in each school are reported in Table 8; of note, very few students from Riverview and Wesley responded to this item. Because so few students from Riverview and Wesley answered the question, only the responses from Fairmont were interpreted. An independent samples t-test showed that there were no statistically significant differences between the responses of Fairmont students with and without learning disabilities ($t_{(219)} = .163$, $p = .871$) on the change item.

<Insert Table 8 about here>

Predictors of Attitudes for Students with and without Learning Disabilities

In addition to investigating differences across schools and student groups, we were also interested in discovering variables that would predict students' attitudes toward computers. Two sets of multiple regression analyses were conducted. The first sought to discover variables related to students' attitudes, the second sought to determine whether differences in attitude between students with and without learning disabilities existed after controlling for the other variables. Separate analyses were conducted for each outcome measure (general attitudes towards computers and the use of computers by students with special learning needs). To include more students than those who participated in both the pre-test and post-test surveys, the post-test survey data were used as the criterion variable for these analyses.

The demographic survey information was reviewed to determine which variables could be predictive of students' attitudes. Twelve variables were initially selected as potential predictor variables. A preliminary regression analysis was conducted and the standardized beta weights and semi-partial correlations for these variables were evaluated. For predicting general attitudes towards computers, nine variables had weights or semi-partial correlations significant at $p < .10$. A subsequent regression analysis was conduced using only these nine variables. Complete data on all nine variables were available for 357 of the students. The multiple correlation was .50, indicating these variables accounted for 25% of the variance in the general attitude post-test data. This multiple correlation using all 12 variables was about the same (.502). The results of this regression analysis are summarized in Table 9. The nine variables included in the equation were computer ownership, computer skills, frequency of computer use, where computer skills were learned, use of word processing, use of educational programs, use of computer games, use of database software, and use of electronic mail. Computer skills, use of computer games, and frequency of computer use exhibited the largest standardized beta weights, (.30, .15, and .16 respectively) indicating they were the best predictors.

<Insert Table 9 about here>

To determine whether differences in general attitudes may exist between students with and without learning disabilities after controlling for these nine variables, the dichotomous student grouping variable (i.e., learning disabled/non-learning disabled) was added to the multiple regression equation. The improvement in variance accounted for was negligible (.005), and was not statistically significant. Therefore, students with and without learning disabilities appear to have similar attitudes toward computers, even after controlling for variables related to computer use.

Multiple regression analyses were also performed using the second outcome measure (attitudes toward the use of computers by students with special learning needs). Using the same nine predictor variables (all zero-order correlations for the other variables were near zero), a multiple R of .19 was obtained, which was not statistically significant ($p = .22$). Adding the dichotomous student grouping variable (learning disabled/non-learning disabled) to the equation resulted in virtually no increase in the multiple correlation. Thus, the results indicated that the students with and without learning disabilities had similar computer use patterns.

Multiple regression analyses are sample-specific and may reflect the vagaries of a particular sample. To ensure the results of the analyses reported above were reliable, the analyses were cross-validated using response data from those students who participated in either the pre- or post-test but who did not complete both surveys ($n = 341$). To compute the cross-validation indices, the regression equations obtained above were applied to the new sample to compute predicted attitude scores. These scores were correlated with the students' observed attitude scores. For the general attitude data, the cross-validation correlation was .44, which was close to the multiple correlation obtained in the initial analysis (.50). For the second outcome measure, the cross-validation correlation was near zero (-.002) which reflected the non-significance of the original multiple correlation (.19). These findings suggest that the conclusions drawn from the regression analyses are reliable.

Discussion

Comparisons by School and Group

Interestingly, the ANOVA results and post-hoc tests showed that there were no significant differences in the overall attitude scores of students with and without learning disabilities. While students with learning disabilities may have unique learning needs, their attitudes about computers may be no different than non-disabled peers. Given the positive effects of computer-based instruction (CBI) for students with learning disabilities, (Fitzgerald & Koury, 1996; Khalili & Shashaani, 1994; Kulik, 1994) it appears that inclusive instructional practices which incorporate computer-based activities could be a parsimonious way to ensure full inclusion of students with learning disabilities in the least restrictive environment of the general education classroom while providing instruction (e.g., CBI) shown to be effective for such students.

Comparisons of the scores obtained by students from the three schools on the two outcome measures showed significant differences in general attitudes about computer use in schools as well as use of computers by students with special needs. Post-hoc tests showed that Riverview's scores differed significantly from both Fairmont and Wesley Academy on both measures. Of note, the scores for Riverview were higher than the other schools on both measures. Related factors may be that Riverview had the youngest students and was supposed to receive a new computer network during the study year. Nonetheless, the existence of these differences between the schools suggests that school environment may be an important factor in students' attitudes about computers. Even though previous researchers (Kinnear, 1995; Murphy, et al, 1989; Proctor & Burnett, 1996) noted the importance of computer access in students' computer attitudes, there is virtually no other research into between-school comparisons of students' computer attitudes and so replication of these findings is needed.

Changes over Time

Repeated measures analysis of variance (RMANOVA) across school and student groups showed that, while there were some changes in attitudes over the course of the study, these were not related to

the implementation of a new computer network. The comparisons showed that school may be related to changes in general and special needs-related computer attitudes over time but these changes were not specific to the treatment condition at Fairmont. This is an important finding because of the focus and importance given to computers in schools and society today (Blackhurst, 1997; Bork, 1997). Just putting computers into the classroom may have no effect on students' attitudes about them.

Similarly, comparisons between students with and without learning disabilities showed that there were minimal differences in the changes in attitudes among these students during the study year. Given that there were no statistically significant changes in the attitudes of students with or without learning disabilities at Fairmont, it appears that the treatment condition did not influence the attitudes of students with learning disabilities differently that those without. The overall similarities in changes between the student groups further supports the finding that having a learning disability is not related to how students view computers.

The Change Question

Fairmont, the experimental site, experienced an infusion of new technology from which students at that school reported an increase in the quality of students' work.. Still, the mean responses for both the students with and without learning disabilities were near the midpoint of the survey scale and must be interpreted cautiously. Overall, it may be that, according to the responses to change item, the experimental condition -- the installation of a campus-wide computer network -- had the expected result of being related to students' perceptions of the relationship of the quality of student work with computer use. However, the difference in the change item scores for Fairmont students with and without learning disabilities was not statistically significantly different, suggesting that both groups of students saw some, if slight, improvement in the quality of students' school work because of the new computer network. This finding contradicts the results from the repeated measures analysis of variance which suggested that the Fairmont students' overall attitudes about computers did not change at all over the course of the school year. Possibly, participants had an overt sense of a change in work quality even though

componential evaluation of such change was not reflected in the pre and post-test scale score comparisons. This finding is in line with many societal expectations of what computers should do for schools and students (Blackhurst, 1997; Bork, 1997). More research into the real changes that computers may offer students is needed.

Predictors of Computer Attitudes

Computer skills, use of computer games, and frequency of computer use were the best predictors of students attitudes about computer use. These findings were in line with prior research (e.g., Kinnear, 1995; Murphy, et al, 1989; Proctor & Burnett, 1996) and suggest that how often students have access to computers and what they use them for may influence their attitudes about the potential benefit of computers for school-related work. The finding that there were no significant differences between the predictive variables for students with and without learning disabilities supports the general comparisons between the student groups; it appears that the variables that best predict students' general attitudes about computers are no different for those students with learning disabilities and those without. These results further support the use of inclusive instructional practices involving computer-based instruction. The results highlight the importance of students' computer skill level and frequency of computer use on their general attitudes about computers (Kinnear, 1995; Murphy, et al, 1989; Olivier & Shapiro, 1993; Proctor & Burnett, 1996). Thus, it appears that ensuring that all students have equitable access to computers is an important step toward enhancing the likelihood that students will view computer use in a positive fashion and be able to take advantage of the benefits that computer-based instruction can offer as suggested by Goldenberg et. al (1984) and Male (1994).

Conclusion

The findings from this survey suggest that there are few differences in the computer-related attitudes of students with and without learning disabilities. The results also indicated that the students' computer attitudes were not linked with the treatment condition of a computer network. There were, however, significant differences in the attitudes of students by school, suggesting that school may be an

important factor in the development of students' attitudes about computers. Evaluation of computer-related variables suggested that computer-related experience is the most important predictor of students' attitudes about computers.

Data concerning the changes in students' attitudes over the course of the school year when a computer network was installed at the Fairmont campus showed that the treatment condition was not related to changes in students' computer-related attitudes. Importantly, the lack of significant difference between the attitudes and changes in attitudes among students with and without learning disabilities suggests that students with learning disabilities may be able to take part in CBI in the general education classroom alongside their non-disabled peers. Such practices allow for inclusive educational approaches which focus on maintaining the least restrictive environment for all students. Additionally, inclusive instruction using CBI allows for resources to be allocated for hardware, software, and teacher training, which will likely further enhance the actual use of computer-based instruction. Given the literature evidence that CBI is especially effective for students with learning disabilities and other special needs, optimizing its use appears to be an important effort for students with special learning needs.

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Table 1

Demographic characteristics of students at each school

School	N	Percent
Fairmont		
Day students (girls)	61 (8)	24 (3)
Boarding students	181	72
International students	52	21
Students with Learning Disabilities	26	10
Students with Attention Deficit Hyperactivity Disorder	19	8
Other disabilities	2	.8
Total	250	
Riverview		
Students receiving special education services	55	14
Students receiving free and reduced lunch	39	9
Non-native English speakers	23	6
Total	393	
Wesley Academy		
Students receiving special education services	49	15
Non-native English speakers	60	18
Total	327	

Table 2

Item categories and individual items

CATEGORY	ITEMS
General attitudes about the use of computers in schools	1. I feel comfortable with my ability to work on a computer.
	2. The thought of using a computer frightens me.
	3. I worry about using computers because I feel like I might break them.
	4. Computers are helpful tools for school assignments.
	5. There should be one or more computers in every classroom.
	6. Computers help make schools more connected to the "real world."
	7. Computers provide information and resources not otherwise available in schools.
	8. Computers make school fun for students.
	9. Writing is easier for students when using a computer.
	10. Students who use computers for school work get better grades.
	11. Computers encourage student imagination and creativity.
	12. Students should be required to learn how to use computers.
	13. Students should use computers regularly to do school-related work.
	14. Computers make it easier for students to succeed in school.
	15. Students receive enough training to use computers for school-related work
	16. Computers help students learn how to work together and solve problems cooperatively.
	17. Computers put pressure on students to learn more and get better grades.
	18. Computers take time away from students working together.
	19. Computers are a distraction to students and take time away from instruction.
Attitudes about use of computers by students with special learning needs	20. Students with special needs believe that computers can help them to improve their grades.
	21. Students with special learning needs believe that computers can help improve the quality of their work.
	22. In general, students with special learning needs believe that computers can help them to compensate for their disabilities.
	23. Computers benefit students with special learning needs more than students without special learning needs.
Change item	24. I believe that the new computers installed this year have helped students to improve the quality of their work.

Table 3

Means (standard deviations) for each scale by school

Group			Outcome Measure			
	pretest	posttest	General Attitudes		Special Needs Attitudes	
	n	n	Pre	Post	Pre	Post
Overall	667	545	68.1 (10.8)	68.2 (10.8)	12.9 (2.8)	12.7 (2.8)
Riverview	108	99	73.2 (10.1)	73.2 (9.5)	13.5 (2.9)	12.7 (3.0)
Fairmont	232,	255	66.1 (11.4)	66.3 (11.0)	12.6 (2.7)	12.6 (2.6)
Wesley	327	191	67.8 (10.1)	68.3 (10.4)	12.9 (2.7)	12.9 (2.9)

Table 4

Means (standard deviations) for each scale by student groups

(students with and without learning disabilities)

Group	pretest n	posttest n	Outcome Measure: General Attitudes Pre	General Attitudes Post	Special Needs Attitudes Pre	Special Needs Attitudes Post
Students with Learning Disabilities	97	65	67.2 (10.6)	69.9 (12.0)	12.8 (2.7)	13.0 (3.4)
Students without Learning Disabilities	497	432	67.8 (8.8)	67.8 (10.8)	12.9 (2.1)	12.6 (2.7)

Table 5

Mean scores (standard deviations) for each pre and post-test scale by school for participants who completed both surveys

Group		Outcome Measure			
		General Attitudes		Special Needs Attitudes	
	n	Pre	Post	Pre	Post
Riverview	71	74.1 (8.99)	72.2 (9.36)	13.5 (3.02)	12.2 (2.69)
Fairmont	176	65.2 (11.99)	66.2 (10.84)	12.6 (2.74)	12.4 (2.56)
Wesley	143	67.6 (10.99)	68.2 (10.72)	12.9 (2.96)	12.9 (2.70)

Table 6

Results from RMANOVA for within and between-school differences from pre to post-test

Source	df	Sum of Squares	Mean Sum of Squares	F	p
General Attitudes Scale:					
School	2	2816.05	1408.02	13.90	.000
Time	1	4.50	4.50	.14	.707
School x Time	2	268.93	134.47	4.22	.015
Error	387	12334.55	31.87		
Special Needs Attitudes Scale:					
School	2	13.62	6.81	1.22	.296
Time	1	49.12	49.12	11.24	.001
School x Time	2	43.70	21.85	5.00	.007
Error	395	1725.82	4.37		

Table 7

Results from RMANOVA for within and between group differences from pre to post-test for students with and without learning disabilities

Source	df	Sum of Squares	Mean Sum of Squares	F	p
General Attitudes Scale:					
Group (LD – non LD)	1	42.44	42.44	.38	.542
Time	1	242.74	242.74	7.11	.008
Group x Time	1	135.71	135.71	3.97	.047
Error	353	12058.44	34.16		
Special Needs Attitudes Scale:					
Group (LD – non LD)	1	6.81	6.81	1.14	.286
Time	1	14.39	14.39	3.07	.081
Group x Time	1	.46	.46	.10	.755
Error	360	1690.15	4.69		

Table 8

Means and standard deviations by group and school for change item

School	N	Mean	SD
Fairmont	221	3.58	1.06
Students with learning disabilities	37	3.57	1.12
Students without learning disabilities	184	3.60	1.01
Riverview	73	3.55	1.17
Students with learning disabilities	7	3.57	1.40
Students without learning disabilities	66	3.53	.95
Wesley	5	2.60	1.82
Students with learning disabilities	-	-	-
Students without learning disabilities	5	2.60	1.82

Table 9

Summary of regression analysis for variables predicting computer attitudes

Variable	B	SE B	Beta	p	R^2_{sp}
Computer skills	3.927	.727	.304	.000	.064
Computer games use	-5.289	1.552	-.163	.001	.025
Frequency of computer use	1.493	.603	.145	.014	.013
Database use	-2.393	1.235	-.094	.054	.008
Education programs use	-1.809	1.072	-.084	.092	.006
Computer ownership	2.455	1.589	.081	.123	.005
Electronic mail use	-1.199	1.177	-.052	.309	.002
Word processing	1.385	1.511	.046	.360	.002
Where learned to use a computer	.444	.554	.038	.424	.001

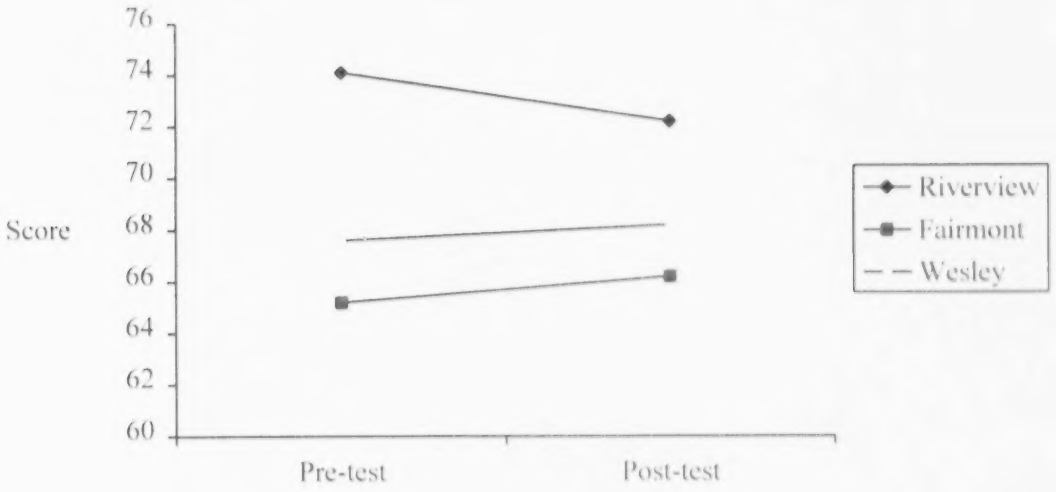
$R^2 = .25$

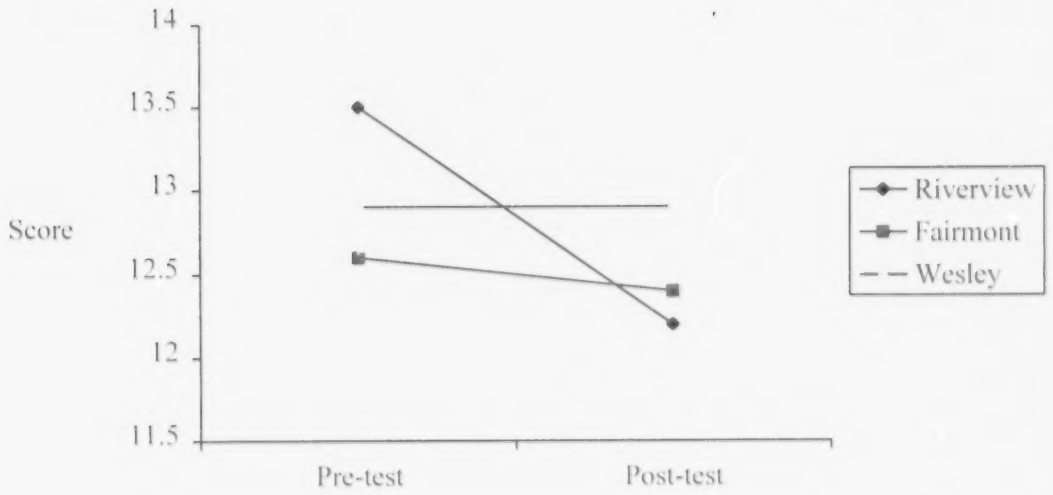
R^2_{sp} = squared, semi-partial correlation

Figure Captions

Figure 1. Pre and post-test means by school for general attitudes scale for students who completed both surveys.

Figure 2. Pre and post-test means by school for special needs scale for students who completed both surveys.


76
74
72
70
68
66
64
62
60
Score
Pre-test
Post-test
Riverview
Fairmont
Wesley


14
13.5
13
12.5
12
11.5
Score
Pre-test
Post-test
Riverview
Fairmont
Wesley